



Ø BEAT

COLO. SPRINGS,
COLORADO

JUNE 1983

PACSAT... A True Technical Innovation

THE PACSAT PROJECT

(Part 2)

Den Connors, KD2S

PACSAT Project Manager

Radio Amateur Satellite Corporation—AMSAT

Spacecraft

As mentioned, the orbit of PACSAT would be sun-synchronous, that is appearing at the same time each day. UoSAT/OSCAR 9 has this type of orbit, and displays this property. Additionally such an orbit guarantees at least two passes per day will be seen by ALL corners of the Earth.

The PACSAT satellite system may be broken into the spacecraft itself, and the experimental packages. The interfaces are defined to be spacecraft/experiment and spacecraft/ground station.

Two options are available for placing PACSAT experiments into space. The possibility of riding the packages inside of a spacecraft built primarily for other purposes exists, and allows the PACSAT design team to avoid the additional complexity of designing and building all of the required subsystems. AMSAT has looked in particular at the future launch opportunities available on the Conestoga-series of launch vehicles to be provided as a commercial venture by Space Systems of America, Incorporated. SSI will be launching payloads directly into low-earth orbit, providing a mechanism for direct injection of PACSAT into its final orbit without requiring on-board propulsion systems in the satellite.

A second opportunity is more in line with AMSAT's additional method of designing the satellite "from the ground up", and will likely provide many more opportunities for future launches. The Space Transportation System (Space Shuttle) has the option of carrying into space sets of three "Get-Away Special" canisters, or GAS cans. Although these cans have traditionally been reserved for inexpensive access for

experimenters who did not require throwing their experiments into space, recent discussions with NASA have shown promise for using such a can as a launch opportunity. A satellite would be placed inside the can, with a mechanism in place to allow the Shuttle crew to remotely open the lid and push the spacecraft into the void (hopefully after opening the Shuttle bay doors).

This new opportunity has two tremendously useful aspects: GAS can opportunities are CHEAP (\$10,000) and potentially plentiful. The drawbacks are the requirements of building such spacecraft as would be required to fit into the can, and providing a propulsion mechanism for altering the very low orbit into which the Shuttle would place the unit, so that a final, more stable orbit would be available. As it happens, there are active international AMSAT groups that are very excited with the possibility of providing both spacecraft and propulsion.

The University of Surrey spacecraft design team (UoSAT) has expressed an interest in continuing their advanced low-cost spacecraft design and construction projects, and view PACSAT as an excellent opportunity for using their integration expertise, and for providing a vehicle to carry other experiments of interest to their group.

The AMSAT/DL team at the University at Marburg, West Germany, has been discussing the possibility of providing an innovative spacecraft engine which would be ideal for such a craft as PACSAT — a steam engine, not unlike those first designed by Hero in ancient Greece. The mechanism for generating steam in space is not difficult, and impinging sunlight on external water tanks could provide a large part of the energy required to heat the water. Heating coils electrically powered in the area of the super-heated steam nozzles would finish the heating job, although calculations prove the amount of

(continued on page 4)

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The Pikes Peak Radio Amateur Association meets on the second Wednesday of every month at the Palmer House Motel, I-25 and Fillmore, at 7:30 p.m. All amateurs and interested parties are invited to attend.

Editor: Don Lohse KBØKQ, 1410 E. LaSalle, Colorado Springs, CO 80907 635-7469

MAY MEETING MINUTES

The May 11, 1983 meeting of the Pikes Peak Radio Amateur Association was called to order at 7:30 p.m. at the Palmer House. 44 members were present. Introductions were initiated, and members described their recent activities. The treasurer's report followed (see below). A discussion of the Swapfest results plus possible changes for next year began. A suggestion was made that a hamfest be considered but was not discussed. Charlie reported that the novice classes had started out great but attendance had tapered off in the last few weeks.

Dave explained the arrangements for the Palmer House. Normal cost is \$25 but the price is lowered depending on the amount of beverages purchased. Dave wanted to keep the meeting as informal as possible and also indicated that there was no cut-off time for being out of the room. The general consensus was that the atmosphere was much more pleasant and comfortable than the church.

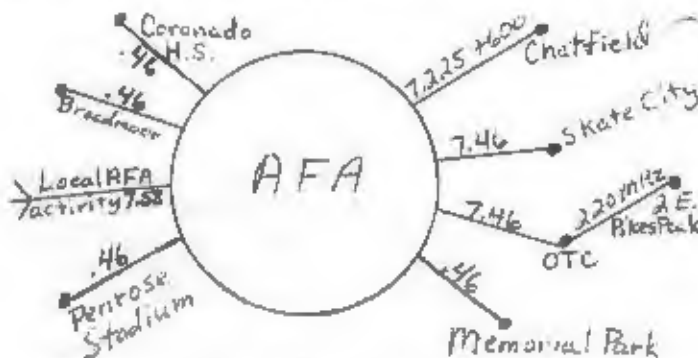
Ken began a series of reports on the National Sports Festival. Approximately 200 hams will be needed, 100 of them during the nine days of games in Colorado Springs. Ken felt it was time to develop a sense of urgency in order to implement this public service; that the planning phase is over and the implementation phase upon us.

The first task will be the torch run on June 14th. It has been done by the club in the past and is already well organized for this year.

Bob spoke on the progress of the club station at the Olympic Training Center. The first task is to set up VHF facilities for the torch run on Pikes Peak and the state-wide run. Two members volunteered use of their 2-meter rigs and several volunteered 2-meter antennas. Several others volunteered use of their HF rigs. The club has antennas but noted they are not high power affairs. Other members will scrounge up tables and chairs. An assembly crew was set up for upcoming weekends.

Operating times and frequencies for the commemorative station are as follows: Phone: 0800—1300 local time; CW: 1300—1800 local time; Phone frequencies: 14.240, 21.340, 7.240, 3.940; CW frequencies: 14.045, 21.045, 7.045, 3.645; Novice frequencies: 7.115, 21.115, 3.715. After 1800 local time, the station will handle traffic nets from the AFA and the OTC.

Steve then reported on the progress of the engineering committee. The main communications station will be at the AFA. It will be tied to several Colorado Springs sites and Chatfield Reservoir in Denver. Frequencies will be 146.46 simplex and 146.58 simplex (on Academy grounds). 147.225 (Conifer repeater) will link Chatfield to the Academy. A 220 MHz link will connect the OTC to headquarters at 2 E. Pikes Peak. A diagram follows.



Mark was commissioned to draft a letter for submission to Festival Headquarters in order to excuse volunteers from work without penalty. He will examine past files for previous letters.

During the meeting, Chuck provided testing equipment for available 2-meter rigs. This testing will continue at the June 8 meeting.

A need was seen for an additional Festival meeting. One was scheduled for May 25. The regular meeting will be June 8. Both will be at the Palmer House.

After the raffle, the meeting was adjourned at 9:50 p.m.

Respectfully Submitted,
Mark Richardson, NØEPF

FCC EXTENDS COMMENT DEADLINE ON NO-CODE

At the request of the ARRL the FCC has decided to allow more time for comments on the proposed no-code licence. The new date is June 28. Remember, 7 (that's right seven) copies of your comment must be sent if you wish the commissioners to read your comments, rather than just placing them in the general file.

MATCHING 75 OHM HARDLINE INTO 52 OHM ANTENNA SYSTEMS (Part 2)

(TNX to Watson Gabriel WB4EXW and the Carolinas-Virginia Repeater Assn. Repeater Journal, Feb. 1980)

Seventeen wavelengths of the coax will be 93.9899 feet long (93 feet 11 7/8 inches). We must now cut our hardline to this length as accurately as we can. One requirement for using this method is to know the original cut length of the coax accurately.

The next step is to put the connectors on the ends. One should be put on just snug enough to make good contact so that measurements can be made because it will have to be removed and re-installed later. The transmitter and SWR Bridge is hooked up to this end. Be sure to either hook the SWR Bridge directly to the end of the hardline or use a half wavelength of coax between the bridge and the hardline with a coax adapter. Connect the 50-ohm load to the other end. All of the following measurements can be made with hardline coiled up in the shack.

Now we must make an SWR versus frequency plot for our hardline. Take readings every 200 KHz except where the SWR approaches 1:1 and then make 100 KHz or less steps. The idea is to find the frequency at which the SWR is 1:1 as accurately as possible. Next we must make a graph of this data as shown in Figure 1 for the coax as found. Notice that the coax is "matched" at 145.4 MHz which is not where we wanted it.

It is very doubtful that our seventeen wavelengths that we wanted is wrong. We will assume that there was some error in our value of the velocity of propagation and that is error is responsible for the coax being matched at 145.4 MHz instead of 144.1 MHz. You will see that it only takes a small error to produce these results.

To calculate the new velocity of propagation we use the matched frequency that we have just found.

First calculate one wavelength,

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Dick Kohlhaas, W5UDM

$$\frac{93.9899 \text{ feet}}{17 \text{ wavelengths}} \left(\frac{12 \text{ inches}}{\text{foot}} \right) = 66.3458 \frac{\text{inches}}{\text{wavelengths}}$$

Now:

$$\text{wavelength} = \frac{11803 (v)}{f \text{ (MHz)}} = \frac{11803 (v)}{145.4} = 66.3458$$

Solve for v and

$$v = .81731$$

We have now calculated the velocity of propagation of our hardline. Now let's find out how long our coax should have been to match at 144.1 MHz.

$$\text{wavelength} = \frac{11803 (v)}{f \text{ (MHz)}} = \frac{11803 (.81731)}{144.1} \text{ inches}$$

$$\text{wavelength} = 66.9444 \text{ inches} = 5.5787 \text{ feet}$$

$$\text{seventeen wavelengths is}$$

$$17 [5.5787 \text{ feet}] = 94.8379 \text{ feet}$$

We now see that our 94 foot length is a little short. Since we cannot lengthen our coax we must cut it down to the next halfwavelength point, which is 16.5 wavelengths.

$$16.5 (5.5787 \text{ feet}) = 92.0486 \text{ feet}$$

To find out how much to cut off the end of the coax, we must subtract the new length from the original length.

$$93.9899$$

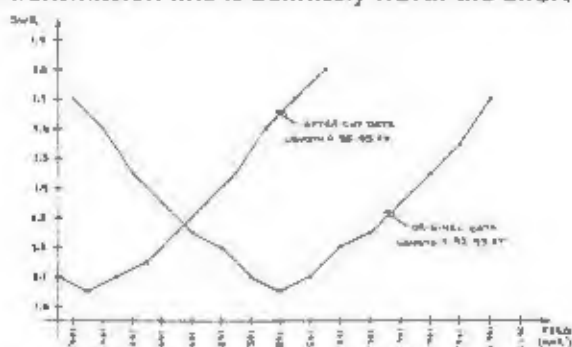
$$-92.0486$$

$$1.9413 \text{ feet} = 23 \frac{5}{16} \text{ inches}$$

Now cut this amount from the end of the coax and re-install the connector. Make another SWR versus frequency plot to check the result. The graph in Figure also shows the plot that I obtained after the cut was made.

Try this method. It definitely works and have a good low-loss transmission line is definitely worth the effort.

Figure 1



Submitted by Karl White K4DQ



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PACSAT (cont.)

water required to alter the orbit of PACSAT is quite modest. Further, the ever-present problem of safety to the Shuttle crew is very much reduced by having spacecraft with extremely non-volatile fuels such as water! Gradual pushes from the steam nozzles at opposite sides of the orbit will nudge PACSAT into its final orbit, and residual water could be used to further occasionally alter the orbit to keep it in a sun-synchronous plane.

PACSAT Communications Experiment Package

Each of two packages will contain a set of uplink and downlink channels with associated analog and digital hardware. Current designs are targeted for typically four uplink channels, each dynamically configurable with respect to data rate. One high-speed downlink channel will be used to support the uplinks, and to provide control over the smart ground stations. For an excellent review of the design effort for the modulation techniques and access modes of these channels, see the paper "Modulation and Access Techniques for PACSAT" by Phil Karn, which is included in these proceedings.

Supporting these communications channels will be a series of filters, oscillators and amplifiers, along with microprocessors and buffer memory for channel control and support of link access protocols. These processors, with perhaps one or two channels per processor, will allow the demodulators chosen to be both adaptive in data rate and frequency agile.

The set of packages will have a common system controller and main memory unit (RAMUNIT). The software to support the higher-level protocols and application programs to be resident in the SCU will be loadable from the ground, a technique now common in the Amateur Satellite Service. A memory package in the megabyte range is being investigated.

Spacecraft/Experiment Interface

The spacecraft will provide the environment for PACSAT, a gradual upgrade path is to be provided for PACSAT use. A required piece of equipment will be the modem, which will include a modulator, demodulator and pass-through path for transmitter push-to-talk and frequency control. This modem will be capable of operating as a stand-alone modem attached to one of the current types of packet radio terminal node controllers (TNC).

Operation of the TNC and modem pair with a standard set of 440-MHz transmitter and 2-meter receiver will allow operation at 1200 baud. Higher speed operation will require a separate rf deck, with direct access to IF strips. Speeds of up to 9600 baud are planned.

A final touch would be a custom TNC specifically designed for this system, and allowing direct interface to other TNCs for ground-based internetwork linking.

It should also be noted that conservative link margin calculations have shown that, with modest transmitter power on board the spacecraft and standard power available to ground stations (around 25 watts), the requirement for having directional antennas is not necessary. Simple gain verticals like 5/8th whips on 440 and 2 will probably be quite adequate, especially at lower baud rates like 1200 baud.

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MAY BOARD MEETING

The May 16 board meeting of the Pikes Peak Radio Amateur Association was called to order at 7:30 p.m. in the home of Dave. Present were Dave NØDV, Mark NØEPF, Jake NØCYR, Bud NØDDF, Les KCØNC, and Tom ADØO.

Don KBØKQ will officially be given a format for the club cards and will be requested to have them printed as soon as possible. Dave moved to purchase 3000 cards, and 100 card holders. Jake seconded the motion and it passed unanimously. This motion effectively negates a previously approved motion to purchase 1000 cards.

Les is preparing a membership roster, and the board felt every member should receive a list. Hopefully, the roster could be printed in Zero Beat by the June or July issue. The list would be mailed only to members and would not contain unpublished phone numbers.

Tom reported the May 25 and June 8 meetings have been approved by the Palmer House.

Bud reported that he has three double duck DF kits (as appeared in QST). Parts are not included. He will announce this at the next regular meeting for those who may be interested in obtaining a kit.

Club caps and jackets may now be purchased from the distributor at the previously published prices. The company is the Shirt Stop at Boulder and Platte. Members should contact Steve Fredrick in the store.

As the club will not be officially sponsoring Field Day activities, money previously spent for it will be used for the OTC station. Also two public service events requests were discussed but had to be turned down due to too short of a notice.

The July program is tentatively proposed as amateur television, fast scan TV.

It was mentioned at the regular meeting that the club should buy a synthesized 2-meter rig. Because of little use, no club station (permanent), and Sports Festival priorities, the consensus of the board was that such a purchase was not warranted at this time.

A volunteer is needed to organize a fox hunt for July or August. An announcement will be made at the next regular meeting.

Tables are built and painted at the station site in the OTC. Antennas will be worked on shortly. Various members have donated equipment. Small items are still needed: clocks, tuners, keys, etc. The club received an

(continued on page 5)

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Icom 21A AC/DC 2 meter FM w/digital VFO \$150.
Santic desk quick charger \$69.
Icom 230 synth. 2 mtr. \$135.
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Swan 200-SS-16-B 80-10m, solid state w/ps 20-20 amp continuous
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out on 10 \$425
Swan 1200W linear \$225.
Hygain TH3 3 element tribander \$150.
Galaxy 5 w/ AC supply and speaker \$195.
Galaxy DC1000 mobile power supply \$25.
LS 400-12 12 volt power supply for Heath/others \$40.
Robot 800 teletype keyboard/TU-exc. condition \$375.
Collins 75A4 Rcvr. Exc. condition \$195.
Collins 755C3 receiver w/ extra 14 socket crystal deck —
Serial # 11997 — Mint \$395.
Kenwood TS 530S Demo w/warranty \$525.
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MEETING NOTICE

The June meeting of the Pikes Peak Radio Amateur Association will be held on June 8 at 7:30 p.m. at the **Palmer House Motel on N. Chestnut Street (just north of I-25 and Fillmore.)** The continuing clinic to help everyone make sure their equipment is up and running properly for the National Sports Festival will be held, along with the making of final plans for this big public service event.. Sign ups for the Festival will be taken — and if you want to work a particular event, come and put your name on the line. All members and other interested persons are encouraged to attend.

SPORTS FESTIVAL

As noted in the meeting announcement, sign up will continue for the festival at the meeting. It is important that we get an idea of what shape the communications will be in, by knowing who is working what, with what equipment, etc. In this issue is a sheet which contains a tentative schedule and an information sheet on your equipment and what events you want to work. Make a copy of the equipment sheet, fill it out and send to Dave WBØSSG at the address listed. Keep the original so you have the schedule, and a record of what information you sent to Dave.

Now is the time to come forward and get involved in this most ambitious and demanding public service event. Sign up early!!!

BOARD MINUTES (cont.)

official okay to use the Festivals' bulk mailing permit and will be sending a letter to area hams enclosing a sign up sheet for the festival. The letter will hopefully be mailed May 21. Help is still needed in setting up the station at the OTC.

There being no further business before the board, the meeting adjourned at 10:11 p.m. Next meeting will be June 13 at Karl's home (K4DQ).

Respectfully submitted,
Mark Richardson — NØEPF

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A LETTER FROM AES

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The 735/135 repeater and autopatch will be moved to a new location soon. The system will be maintained and operated in the same manner as before. Funding will also continue through voluntary contributions which will be handled by Don KBØNN or Jera NØAGT.

We want to thank our customers for their support during the past nine years. We've gained new friends, met many interesting people, and learned invaluable knowledge in the process. We'll miss the friendly chats over coffee, the lively discussions, and the people who make each business day worthwhile.

73's

Jera NØAGT

Dave WDØCDU

(Editor's Note: I would like to thank Dave and Jera for their support of Zero Beat and the PPRAA over the years. They were always willing to help out in any way they could, and they will be greatly missed. Sometimes we don't tell people how much we appreciate their efforts, and we would be remiss if we did not do so now. Best of luck in your new venture!!)



**Did You
Remember To
Sign Up
For The
Sports Festival??**

FESTIVAL SIGN UP

The number of people signing up for Sports Festival work has been relatively small. This is creating a real problem, as Dave WBØSSG, the man coordinating all the workers, has no names to fill in the slots! Please, please, please, sign up! This is an incredibly important thing to do. The Festival people are depending on us to do our job, and that requires people. Commit some of your time to help out in this big public service event. We cannot afford to go right down to the end without knowing who is willing to work. Look at the schedule enclosed in this issue and make up your mind. Get your name in, and if you don't see an event you like, or want to just help out, let that be known too! We need help in many areas. Pitch in, and make the Festival a public service event we can all be proud of!

PACSAT (cont.)

Spacecraft/Ground Station Interface

The PACSAT Project intends to use omnidirectional antennas on two of the most popular vhf/uhf bands, in a mode which will be familiar to Phase III users. Uplinks will be available at around 435 MHz, and choice of the proper channel will be made by the ground station controller, following the command requests of the satellite. The common downlink will appear at the edge of the Amateur Satellite allocations, probably around 145.806 MHz for one package and 145.994 MHz for the other.

The modulation technique, synchronization requirements, encoding mode and related parameters are to be determined, based on experiments to be performed by two different design teams this spring. It is assumed that either differentially-encoded phase-shift keying or minimum shift keying at rates in the 1200 to 9600 baud range, perhaps adaptively available, are the most likely candidates.

The link-level access protocols, that is, the addressing and error detection schemes are planned to be compatible with the AX.25 Amateur packet radio protocol standard. This protocol has already been implemented by several groups, and is a de facto AMSAT standard for all currently-planned packet satellite efforts.

The network protocol will probably support AX.25 network-level protocol, and perhaps also less complicated (and less reliable) "datagram-type" protocols as well.

The memory interface between ground stations and on board RAMUNIT will be little more than a virtual disk drive, with a very noisy connecting link. On top of this protocol will lie an applications program which will provide a number of message and file services. Experimenters will be provided with lower-level accesses to the system where such access does not significantly disrupt normal use of the system.

PACSAT Project Status

The final conceptual review meeting was held in February 1983, and several of the design groups attended, including representatives from both VITA and the University of Surrey. Many of the more sophisticated concepts were thrown away to provide an easier target for scheduling. There will be a set of subsystem design meetings at this conference, and further meetings to be held later this spring. Negotiations are currently underway with the candidate launch agencies and design support groups.

System design is likely to be completed early this summer, with deliverable items to be integrated and tested this fall. Following critical design review meetings, spacecraft-ready subsystems will be prepared and shipped to the integrating agency by next spring. Such a schedule would allow AMSAT to take advantage of possible launch opportunities as early as late 1984. Slippages will be inevitable however, and more realistic times will in general coincide with the more likely target launch dates, early 1985 to 1986.

The project now has the support of twelve different design groups from four different countries, but is still in need of qualified hardware and software designers to help review all aspects of the current design, and provide needed manpower with several of the more

important subsystems. PACSAT is an all-volunteer effort and will require careful evaluation by the general user community during its initial phases to confirm design parameters and provide guidance in the utility of the various modes. It is hoped that this system will not only provide many services which are forecast for the digital future of ham radio, but also create a whole new set of users and uses yet to be imagined.

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